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Trends in Pre-hospital Delay in Patients with Acute Myocardial Infarction (From The Worcester Heart Attack Study)

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Delay in seeking medical care following symptom onset in patients with an acute myocardial infarction (AMI) is related to increased morbidity and mortality. Duration of pre-hospital delay in patients hospitalized with an AMI has not been well characterized over time and potentially changing patient characteristics associated with prolonged delay are not well understood. The study sample consisted of 5,967 residents (mean age = 76 years; 39% women) of the Worcester, MA, metropolitan area hospitalized with AMI in 11 one-year periods between 1986 and 2005. The mean and median delay times have remained essentially unchanged during the past 2 decades. The mean and median pre-hospital delay times were 4.1 and 2.0 hours, respectively, in 1986, 4.7 and 2.2 hours, respectively, in 1995 and 4.6 and 2.0 hours, respectively, in 2005. Approximately 45% of patients with AMI presented within 2 hours of acute symptom onset while an additional one third presented between 2 and 6 hours after the onset of acute coronary symptoms. Advancing age and a history of either diabetes or MI were associated with prolonged delay. Compared to patients arriving within 2 hours of symptom onset, those with prolonged pre-hospital delay were less likely to receive thrombolytic therapy and a percutaneous coronary intervention within 90 minutes of hospital arrival. In conclusion, the results of this population-based study suggest that a large proportion of AMI patients continue to exhibit prolonged pre-hospital delay.

Introduction

Using data from a community-wide surveillance study of patients hospitalized with acute myocardial infarction (AMI) in a large central New England community^{1–3}, we examined 2 decade-long trends (1986–2005) in duration of pre-hospital delay, the relation between time to hospital presentation and several patient associated characteristics, and the association between extent of pre-hospital delay and hospital receipt and timing of various coronary reperfusion interventions. The study population consisted of 5,967 residents of the Worcester, Massachusetts, metropolitan area hospitalized with AMI in all area medical centers in 11 annual periods between 1986 and 2005 in whom information about time of acute symptom onset and hospital arrival was available based on the review of hospital medical records.

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Methods

Data for this study were derived from the Worcester Heart Attack Study. This is an ongoing population-based investigation that is examining long-term trends in the incidence, hospital, and post-discharge case-fatality rates of AMI among residents of the Worcester metropolitan area (2000 census estimate = 478,000) hospitalized at all 16 greater Worcester medical centers^{1–4}. Fewer hospitals (n=11) have been included during recent study years due to hospital closures, mergers, and conversion to chronic care facilities. The details of this study have been described previously^{1,3}. In brief, the medical records of patients hospitalized for possible AMI were individually reviewed and a diagnosis of AMI was validated according to predefined criteria^{1,3}. Patients who developed AMI secondary to an interventional procedure or surgery were excluded from the study sample.

Demographic, medical history, and clinical data were abstracted from the hospital medical records of patients with confirmed AMI by trained study physicians and nurses. Pre-hospital delay was defined as the time interval between when the patient reported becoming acutely or severely ill (symptom onset time) and arrival time in the emergency department^{5,6}. The cut-points of <2 hours and ≥2 hours were chosen to distinguish early from late responders to their symptoms of AMI based on the distribution of delay times in the present study sample and from the previously published literature. Hospital associated delay to the receipt of a percutaneous coronary intervention (PCI) or thrombolytic therapy was defined as the interval between the patient's arrival time in the emergency department of greater Worcester medical centers and receipt of coronary reperfusion therapy. Two time cut-points of <90 minutes and ≥90 minutes, and of <120 minutes and ≥120 minutes, were chosen to distinguish early from late receipt of coronary reperfusion therapy. Information was collected from hospital charts about patient's age, sex, race, marital status (single, married, divorced, widowed), comorbidities (e.g., angina, diabetes, hypertension, stroke), AMI order (initial vs. prior), type (Q wave vs. non-Q wave) and location (anterior vs. other), hospital treatment approaches, and hospital discharge status. Information was collected about the occurrence of clinically significant in-hospital complications including stroke⁷, atrial fibrillation⁸, heart failure⁷, and cardiogenic shock².

Information about body mass index (BMI) was recorded by trained data abstractors beginning in 1995. Whether the AMI was a non-ST segment elevation myocardial infarction (NSTEMI) or an ST segment elevation myocardial infarction (STEMI) was recorded beginning in 1997 as was information about the patient's chief symptom complaint. Chest pain and dyspnea were the only 2 chief complaints associated with a >5% prevalence in our study sample; therefore, all other symptoms of AMI (e.g., left arm pain, cough, jaw pain) were combined into an 'other' category.

We examined differences in demographic and clinical characteristics, treatment practices, and hospital outcomes between patients according to extent of pre-hospital delay through the use of chi-square and t-tests for discrete and continuous variables, respectively. Analysis of variance was used to examine the significance of differences over time in average duration of pre-hospital delay. The Wilcoxon rank sum test was used to examine approximately 20-year (1986–2005) trends in median delay times. Logistic regression analysis was used to examine the association between patient-related demographic and clinical factors and year of study with extent of delay.

Results

During the 20-year period under study, a total of 10,310 patients were admitted to all greater Worcester medical centers with confirmed AMI. Of these, information regarding pre-hospital

delay was not available in the medical records of 4,343 (42%) patients; these patients were not included in the present analysis. The proportion of patients in whom information about pre-hospital delay was available did not change appreciably over time. Compared to patients without information on pre-hospital delay, patients in whom data on pre-hospital delay were available were significantly younger, more likely to be male, but less likely to have a history of stroke, diabetes, heart failure, or hypertension. The present report is based on the 5,967 patients in whom extent of pre-hospital delay could be determined.

Over the 20-year study period, the average duration of pre-hospital delay in greater Worcester residents hospitalized at all area medical centers with AMI did not change materially (Figure 1). The mean and median pre-hospital delay times were 4.1 and 2.0 hours, respectively, in 1986, 4.7 and 2.2 hours, respectively, in 1995 and 4.6 and 2.0 hours, respectively, in 2005. When patients with prolonged delay (>24 hours) were excluded (n=120), the mean and median pre-hospital delay times were 3.6 and 2.0 hours, respectively, in 1986, 3.9 and 2.0 hours, respectively, in 1995 and 3.7 and 2.0 hours, respectively, in 2005.

Overall, approximately 45% of patients with AMI presented to greater Worcester hospitals within 2 hours of acute symptom onset, 34% presented between 2 and 6 hours after symptom onset, and 21% presented 6 or more hours after the onset of acute coronary related symptoms. No significant differences in the distribution of pre-hospital delay patterns were observed over the early (1986/1988), middle (1995/1997) and most recent (2003/2005) periods of study (Figure 2).

Compared to patients who presented within 2 hours of AMI symptom onset, patients who delayed for 2 or more hours were older, more likely to be female, to be widowed, and to have a history of angina, diabetes, hypertension and heart failure; these patients were less likely to present with a Q-wave AMI and were more likely to have experienced their heart attack symptoms in the evening or early morning (Table 1). Patients with prolonged pre-hospital delay were more likely to have developed heart failure complicating AMI but less likely to have developed cardiogenic shock during the acute hospitalization. Patients with prolonged delay were less likely to have been treated with thrombolytic therapy, and to have undergone cardiac catheterization and PCI, compared to those who presented within 2 hours of acute symptom onset.

Since previous work has suggested that patients with an evolving AMI may derive some benefits from the administration of thrombolytic therapy in upwards of the first 6 hours of acute coronary related symptoms^{5,8}, we further classified those presenting >2 hours after AMI symptom onset into two categories of 2–5.9 hours and ≥6 hours. Essentially similar demographic, clinical, and treatment factors were associated with more extended delay when these different cutpoints were utilized (data not shown).

We examined whether the characteristics of patients who exhibited prolonged delay changed over the 20 year period under study. In general, there were only a few changes over time in the characteristics of patients exhibiting prolonged delay (Table 2). Patients with prolonged delay were less likely to have been previously diagnosed with angina, less likely to have been divorced, and more likely to have undergone PCI during the most recent years of study (2003/2005) compared to the early and middle years of our investigation.

After controlling for several potentially confounding factors, advanced age and a history of diabetes were significantly associated with delays beyond 2, as well as beyond 6, hours (Table 3). Age >55 years, a history of diabetes, and presence of a previous AMI were associated with delaying 2 or more hours in seeking acute medical care. A history of diabetes or AMI, and hospitalization between 1990 and 1999, were associated with delays in seeking medical care

6 hours or more. Patients who experienced chest pain as their chief complaint of AMI were less likely to delay 6 or more hours after the onset of acute symptoms.

Given the time-dependent efficacy of thrombolytic therapy and PCI, we examined the association between extent of pre-hospital delay and receipt of these coronary reperfusion strategies. Among patients who received thrombolytic therapy or PCI, prolonged pre-hospital delay was associated with longer delays in receipt of these therapies subsequent to hospitalization. Thrombolytic therapy was administered within 90 minutes of hospital arrival to nearly 3/4 of patients with a pre-hospital delay <2 hours whereas this treatment regimen was administered within 90 minutes of hospital arrival to just over half of patients who delayed seeking medical care by 2 or more hours (Table 4). A PCI was more than twice as likely to be performed within 90 minutes of hospital admission in patients who presented earlier after acute symptom onset (Table 4). Similar findings were observed when we used a 2 hour cut-point for hospital associated delays in the administration of coronary reperfusion therapies (Table 4). When we excluded patients who received these treatment modalities more than 6 hours after presenting at the hospital, the results did not change; patients with prolonged pre-hospital delay were significantly less likely to have received coronary reperfusion therapy within 90 or 120 minutes of hospital arrival (data not shown).

When we stratified the analysis of timing of reperfusion therapy according to the presence of a STEMI or non-STEMI, we found that in patients with a STEMI, PCI was performed within 90 minutes of hospital presentation in 10.8% of patients with a pre-hospital delay <2 hours whereas PCI was performed within 90 minutes of hospital arrival in 5.3% of patients who delayed care seeking ≥ 2 hours ($p < 0.01$). In patients with a non-STEMI, there was no difference in the timing of PCI according to pre-hospital delay. There were also no differences in the timing of receipt of thrombolytic therapy according to extent of pre-hospital delay in patients with either a STEMI or non-STEMI.

There were no significant changes over the periods under study in the association between duration of pre-hospital delay and hospital associated delays in the administration of coronary reperfusion therapies (Table 4). The single exception to this trend was that patients with a pre-hospital delay <2 hours were more likely than those who delayed seeking care longer to undergo a PCI within 90 minutes of hospital arrival in the later (2003/2005) as compared to the middle (1995/1997) study years.

Discussion

The results of this community-wide study of greater Worcester residents hospitalized with AMI between 1986 and 2005 suggest that a large proportion of patients continue to have prolonged delay in seeking medical care after the onset of AMI related symptoms. Mean and median delay times have not changed substantially over the 20-year study period nor have the characteristics of patients exhibiting prolonged delay. Increasing age and a history of either diabetes mellitus or prior AMI were associated with delays in seeking medical care in each of the time periods examined.

The few studies that have examined changing trends in care seeking behavior in patients hospitalized with AMI have found little change in median delay times during the 1990's^{1,7}. The mean, median, as well as distribution of delay times we observed during each of our years under study are consistent with the results of previously published studies. For example, in the Atherosclerosis Risk in Communities (ARIC) study, there were no significant changes in the proportion of patients delaying 4 or more hours after the onset of AMI associated symptoms between 1987 and 2000⁹. In the European Heart Surveys 1 and 2, median pre-hospital delays were just over 2 hours and just under 3 hours, respectively^{10,11}. A recent report from the

National Registry of Myocardial Infarction found that the average delay time decreased only slightly from 123 minutes to 113 minutes between 1995 and 2004¹².

In general, the characteristics associated with prolonged delay have been relatively similar across studies and have not changed appreciably over time. Consistent with previous reports^{1,7,12,13,14}, we found that increasing age and a history of either diabetes or AMI were significantly associated with prolonged pre-hospital delay and these patient characteristics were relatively unchanged over the period under study. Patients with diabetes or a prior AMI may be less likely to have classic symptoms of AMI than younger, non-diabetic patients with a first AMI, resulting in longer pre-hospital delay.

Prolonged delay in seeking timely medical care was associated with longer hospital associated delays in the administration of coronary reperfusion therapy. Much of the previous work on pre-hospital delay and time to treatment was conducted in the 1990s and focused primarily on the timely receipt of thrombolytic therapy^{5,13,15}. Consistent with the results of these studies, we found that patients who delayed >2 hours following acute coronary symptom onset were significantly less likely to receive thrombolytic therapy in a timely manner. We failed to observe changes over time in the association between delay time and time to receipt of thrombolytic therapy.

There are several limitations to the present study. We were able to obtain information about pre-hospital delay in only slightly more than one half of patients with confirmed AMI due partially to the extent and quality of information contained in hospital medical records as well as potential for recall on the part of patients. Therefore, the present results should be interpreted with appropriate caution. We did not collect information on the reasons why patients delayed seeking medical treatment due to our methods of data collection and primary reliance on medical chart abstraction. In future studies, the systematic collection of pre-hospital delay data, including reasons for delay from the patients' perspective, may help in developing more targeted interventions and reducing the magnitude of missing data. It would also be useful to study the importance of bystanders, the role of acute situational factors, socioeconomic status, medical insurance coverage, and cultural reasons for delays in care seeking in the setting of acute coronary symptoms.

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Figure 1.
Trends in mean and median duration of pre-hospital delay (Worcester Heart Attack Study)

Figure 2.
Trends in duration of pre-hospital delay (Worcester Heart Attack Study)

Table 1

Characteristics of patients with acute myocardial infarction (AMI) according to extent of pre-hospital delay (Worcester Heart Attack Study)

Characteristic	Pre-hospital Delay		p-value
	< 2 Hours (n=2,700)	≥2 hours (n=3,267)	
Age (years, mean)	66.2	68.6	<0.001
Female	36.1%	40.8%	<0.001
Marital Status			
Single	10.9%	9.7%	
Married	63.3%	61.1%	
Divorced	7.1%	6.7%	
Widowed	18.2%	22.7%	<0.001
Body Mass Index (Kg/m ²)			
<25	31.2%	33.4%	
25 – 29	38.9%	38.5%	
≥30	29.9%	28.2%	0.37
Medical history			
Angina pectoris	24.8%	27.7%	<0.05
Diabetes mellitus	24.8%	30.1%	<0.001
Hypertension	58.4%	61.5%	<0.05
Heart failure	15.0%	16.9%	<0.05
Stroke	8.7%	9.2%	0.55
AMI characteristics			
Initial	66.3%	66.8%	0.65
Q-wave	40.7%	37.5%	<0.05
Anterior	28.3%	29.7%	0.22
Chief symptom complaint			
Chest Pain	70.3%	67.2%	0.07
Dyspnea	9.0%	10.0%	0.37
Other	17.8%	19.0%	0.41
Weekday hospitalization	30.3%	28.1%	0.49
Time of day symptom onset			
6–11:59 AM	29.3%	25.6%	
Noon – 5:59 PM	25.7%	22.3%	
6 – 11:59 PM	23.9%	26.8%	
Midnight – 5:59 AM	21.1%	25.3%	<0.001
Clinical complications			
Atrial fibrillation	15.5%	16.4%	0.36
Heart failure	30.8%	35.5%	<0.001
Cardiogenic shock	6.1%	4.7%	<0.05
Thrombolytic therapy	30.1%	17.6%	<0.001
Intervention procedures			
Cardiac catheterization	47.0%	42.9%	<0.001
Percutaneous coronary intervention	25.3%	19.7%	<0.001
Coronary artery bypass surgery	4.2%	5.1%	0.08
Died during hospitalization	9.7%	8.9%	0.29

Table 2
Percentage of patients with acute myocardial infarction (AMI) who exhibited prolonged pre-hospital delay (>2 hours) according to study year (Worcester Heart Attack Study)

	1986/1988	1995/1997	2003/2005	p-value
Age, years				
<55	49.7%	49.6%	45.8%	0.43
55–64	47.4%	55.7%	49.5%	0.65
65–74	56.1%	54.2%	52.2%	0.40
≥75	59.4%	60.2%	56.5%	0.38
Female	55.6%	58.0%	54.6%	0.72
Male	52.4%	54.1%	50.6%	0.48
Marital Status				
Single	50.8%	43.3%	51.4%	0.64
Married	54.4%	54.4%	51.7%	0.35
Divorced	68.6%	53.9%	48.1%	<0.05
Widowed	50.0%	59.8%	56.8%	0.22
Body Mass Index (Kg/m ²)				
<25	-	57.7%	51.7%	0.11
25 – 29	-	55.7%	53.5%	0.53
≥30	-	56.4%	53.1%	0.41
Medical History				
Angina pectoris	57.3%	62.9%	46.6%	<0.05
Diabetes mellitus	56.3%	61.7%	58.1%	0.81
Hypertension	52.4%	58.4%	53.7%	0.97
Heart failure	50.5%	57.8%	54.9%	0.60
Stroke	49.2%	62.1%	52.0%	0.91
AMI order				
Initial	56.2%	55.2%	51.7%	0.09
Prior	47.7%	56.5%	53.2%	0.23
AMI type				
Q-Wave	52.2%	55.1%	48.9%	0.58
Non-Q-wave	55.2%	55.9%	53.2%	0.41
AMI location				
Anterior	54.1%	60.5%	49.0%	0.75
Inferior/posterior	53.2%	53.8%	52.7%	0.78
Day of hospitalization				
Weekday	54.4%	56.9%	53.9%	0.67
Weekend	51.8%	52.3%	48.0%	0.51
Time of day				
6 – 11:59 AM	55.4%	57.3%	57.8%	0.48
Noon – 5:59 PM	51.2%	61.8%	55.4%	0.67
6 – 11:59 PM	54.5%	50.0%	46.9%	0.71
Midnight – 5:59 AM	53.2%	54.5%	50.2%	0.56
Clinical Complications				
Atrial fibrillation	52.3%	58.3%	55.8%	0.55
Heart Failure	55.0%	59.5%	57.6%	0.51
Cardiogenic shock	54.6%	50.0%	44.4%	0.34
Thrombolytic Therapy	37.7%	42.1%	28.6%	0.87
Cardiac Catheterization				
Underwent	49.8%	52.5%	52.3%	0.60
Did not undergo	55.1%	58.4%	51.9%	0.59
Percutaneous Coronary Intervention				
Underwent	44.0%	44.3%	51.9%	<0.05
Did not undergo	53.9%	58.2%	52.6%	0.98
Coronary artery bypass surgery				
Underwent	50.0%	69.7%	48.9%	0.37
Did not undergo	53.7%	54.7%	52.4%	0.52
Died during hospitalization	49.5%	49.5%	56.9%	0.42
Survived hospitalization	54.4%	56.2%	52.0%	0.27

Table 3
Factors associated with prolonged pre-hospital delay (Worcester Heart Attack Study)

Characteristic	Delay ≥ 2 Hours		Delay ≥ 6 Hours	
	Adjusted OR	95% CI	Adjusted OR	95% CI
Age (years)				
55–64	1.19	1.01, 1.41	1.09	0.82, 1.46
65–74	1.26	1.07, 1.48	1.35	0.91, 1.98
≥75	1.56	1.32, 1.84	1.53	0.89, 2.61
Female	1.05	0.93, 1.17	0.96	0.82, 1.11
White Race	1.01	0.94, 1.08	0.97	0.89, 1.06
Marital Status				
Single	0.98	0.82, 1.17	1.17	0.94, 1.45
Divorced	1.01	0.81, 1.25	1.15	0.88, 1.49
Widowed	1.04	0.89, 1.22	1.03	0.86, 1.25
Medical history				
Angina pectoris	1.10	0.97, 1.25	0.94	0.81, 1.11
Diabetes mellitus	1.26	1.11, 1.42	1.19	1.02, 1.37
Hypertension	1.05	0.93, 1.18	0.91	0.79, 1.05
Heart failure	0.96	0.81, 1.13	1.05	0.86, 1.28
Stroke	0.90	0.74, 1.08	0.95	0.76, 1.21
AMI characteristics				
Initial	0.84	0.74, 0.95	0.81	0.69, 0.93
Q-wave	1.11	0.99, 1.24	0.94	0.82, 1.09
Anterior	0.98	0.87, 1.11	0.96	0.82, 1.11
Chief symptom complaint				
Chest pain	0.91	0.75, 1.10	0.78	0.62, 0.98
Shortness of breath	0.92	0.67, 1.25	0.98	0.68, 1.41
Weekend	0.95	0.84, 1.07	0.98	0.85, 1.13
Died during hospitalization	1.16	0.95, 1.41	0.94	0.73, 1.19
Study year				
1990/1991	1.17	0.97, 1.41	1.41	1.12, 1.78
1993/1995	1.18	0.98, 1.41	1.39	1.11, 1.74
1997/1999	1.10	0.85, 1.4	1.56	1.15, 2.10
2001/2003	0.93	0.73, 1.18	1.07	0.78, 1.45
2005	0.95	0.71, 1.26	1.25	0.88, 1.79

Reference groups are those < 55 years, males, nonwhite race, married, absence of selected medical conditions, previous AMI, non Q-wave AMI, inferior or posterior AMI, presenting with chief symptom complaint other than chest pain or dyspnea, hospitalization during the week, survived hospitalization, and study years 1986/1988.

Table 4
Hospital associated delay to receipt of selected coronary reperfusion therapy
according to extent of pre-hospital delay (Worcester Heart Attack Study)

Pre-hospital Delay	In-hospital Delay			
	Thrombolytic Therapy (n=329)		Percutaneous Coronary Intervention (n=773)	
	<90 Minutes	< 120 Minutes	<90 Minutes	< 120 Minutes
Total Sample				
< 2 Hours	71.6	81.3	7.6	18.1
≥ 2 Hours	61.2	71.6	3.1	12.9
p-value	<0.005	<0.001	<0.001	<0.05
1995/1997				
< 2 Hours	75.4	83.1	5.6	12.1
≥ 2 Hours	68.2	78.3	3.5	10.3
p-value	0.16	0.28	0.47	0.69
2003/2005				
< 2 Hours	68.7	87.5	10.0	23.1
≥ 2 Hours	100.0	100.0	2.5	17.6
p-value	0.50	0.71	<0.001	0.11